

# Cooling Systems for Prime Power and Back-up Power Generation



NARSA 7<sup>th</sup> Annual Heavy  
Duty Heating and  
Cooling Conference

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## ***Cooling Systems for Prime Power and Back-up Power Generation***

### ***COOLING BASICS***

*Basic cooling requirements (and common pitfalls!)*

- 40% of all engine problems originate in the cooling system (Cummins Filtration)

### ***WHAT'S TRENDING in POWER-GEN***

*What's New and "Hot" in Power Generation Cooling*

***Cooling Systems for Prime Power and Back-up Power Generation***

***COOLING BASICS***

## ***Power Generation: Terminology***



ISO-8528 defines basic generator set rating categories.

Emergency Standby Power (ESP): “duration of outage”; “24 hour average is 70% of ESP nameplate rating”; “no overload allowed”

Prime Running Power (PRP): “unlimited number of hours per year”; “Overload is typically available”; Typically 10% lower power than ESP.

Limited Time Prime (LTP): “up to 500 hour per year”; “peak shaving”; “no overload requirement”

Continuous Operating Power (COP): “unlimited hours per year”; “No overload allowed”. Typically 25 to 30% lower power than ESP.

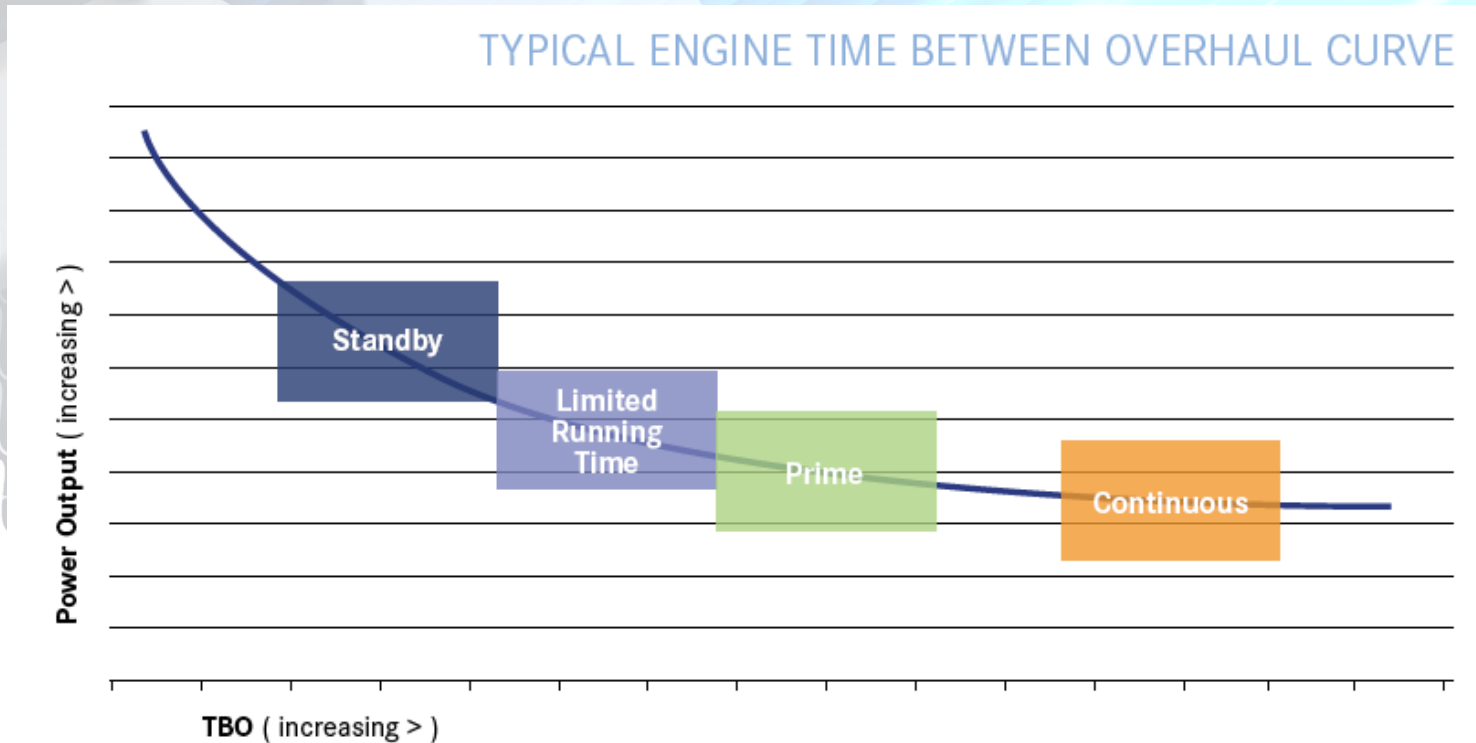


Engine Mfg’s. often have their own guidelines.



Engine performance (and cooling requirements) are often different depending on the rating.

## *Power Generation: Terminology*



- Standby Duty usually higher power (more cooling demand).
- Standby Duty has more frequent maintenance.



What do the ratings mean to radiator design?

- Use the correct engine datasheet
- Reduced fan speeds for Prime duty; even lower for Continuous
- More structural reinforcement for Prime and Continuous
- Some suppliers may take “shortcuts” for Standby designs (e.g., using the motor service factor to achieve margin in motor power)



Proper RAD design requires accurate and complete description of the application.

- Engine make, model and rating (engine datasheet); datasheet of existing RAD if replacement application.
- Environment:
  - Site elevation and maximum ambient air temperature
  - Minimum air temperature if extreme
  - Special fouling considerations (dust, sand, debris)
  - Special chemical considerations (marine corrosion)
- Space constraints
  - Within engine compartment or enclosure
  - Location of remote radiator relative to engine
    - Too high: intermediate heat exchangers are needed.
    - Too far away: auxiliary pumps may be needed.



Proper RAD design requires accurate and complete description of the application (Cont'd.).

- On-engine? What is the fan speed or what fan drives are available?





## Variation in Cooling: Different RADs, same conditions

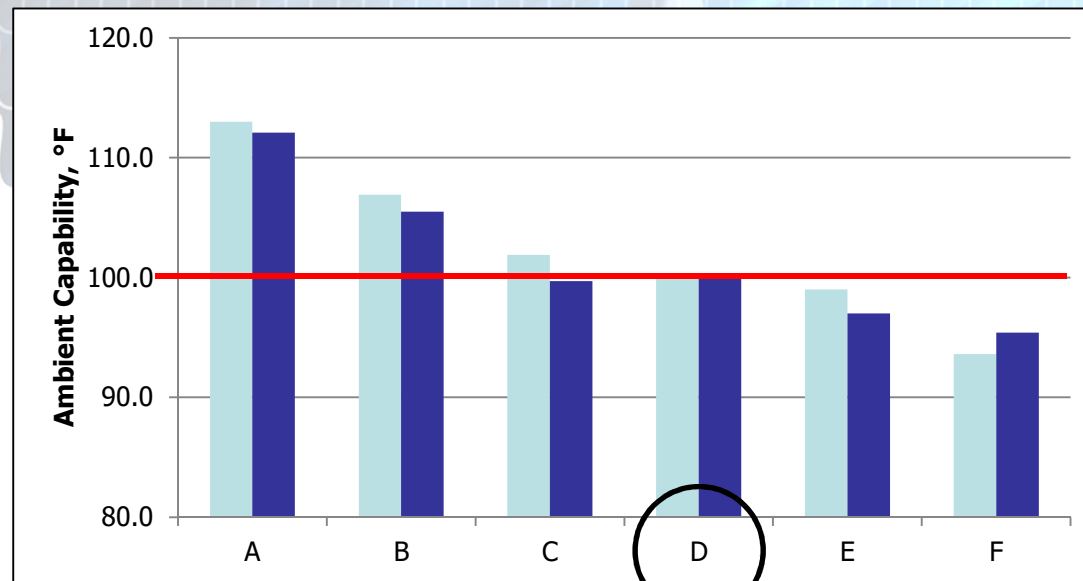
### Typical "process" variations:

- Coolant Flow Rate
- Cooling Air Flow
- Coolant Inlet Temperature (high for jacket water, low for aftercooler)

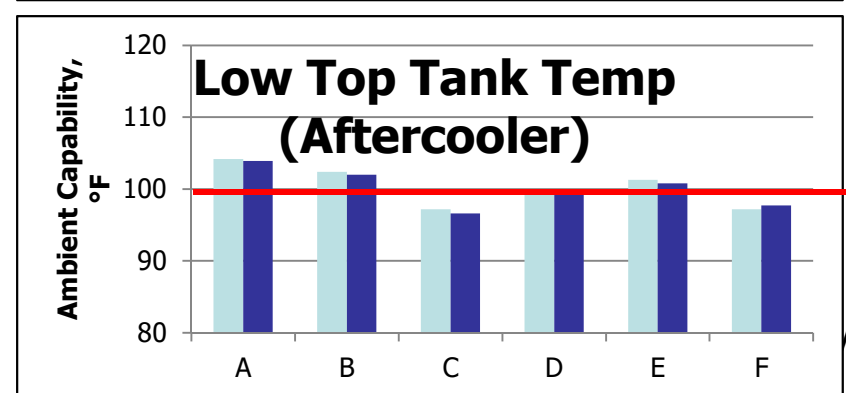
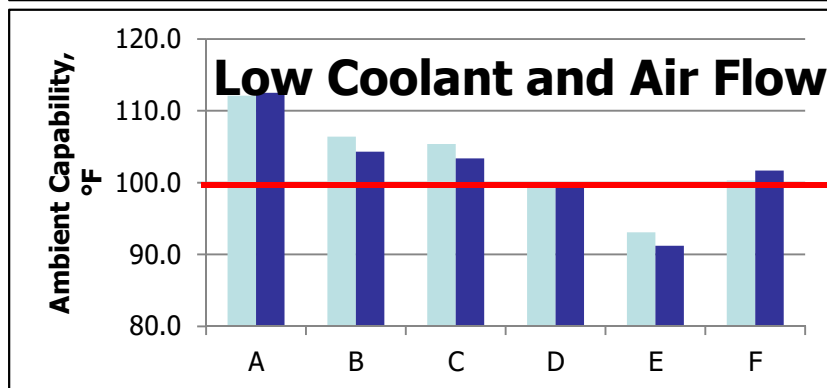
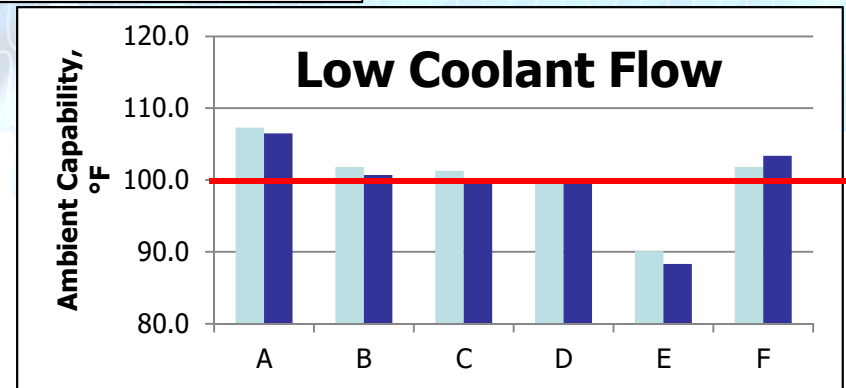
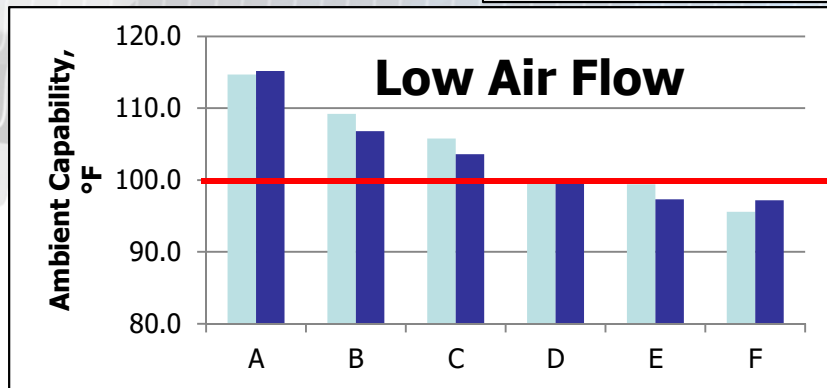
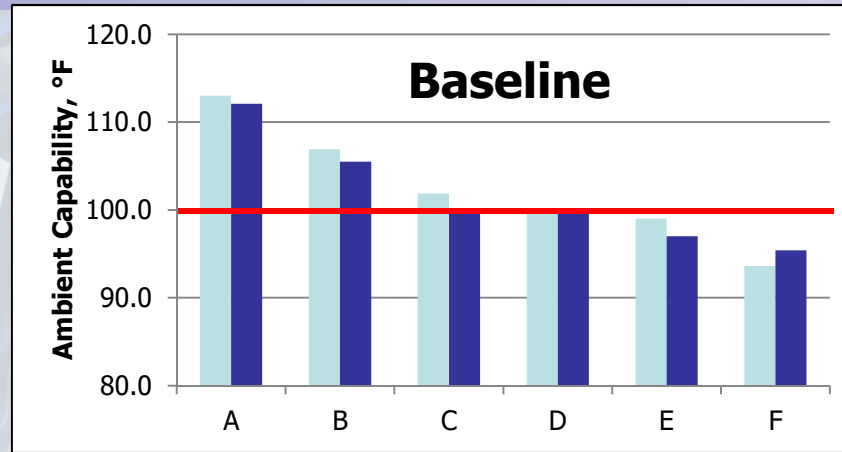
### Possible Core Variations:

- Physical Size
- Fin Density
- Core Type
  - 1/2" Tubes
  - 3/4" Tubes
  - Flat, Dimpled or Louvered Fins
  - In-line, Staggered or Canted Tubes

- Six different core types (A-F).
  - All cores are same dimension (LxWxD).
  - All have same fin density (plate fins)
- Light Blue: All with same air velocity
- Dark Blue: Air flow corrected against fan curve



Reference Core



- It is Not “One Size Fits All”
- Details about cooling requirements are absolutely needed to select the correct core

Check that the supplier has reviewed your coolers design and is proposing the correct thermal solution. There are suppliers who have only one fin alternative and try to provide solutions for all engines with it. Clearly they will be making design compromises in order to win the order, so be careful and look for a company that has design alternatives, not just one choice. Also, ask the supplier how he knows his proposed cooler design will satisfy your thermal requirements. Has the fin arrangement been independently tested?

*(from CAC fabricator)*

**Know the Application!!!**

## ON AND OFF HIGHWAY

Join the growing list of Tier 1 truck and bus manufacturers that trust Rocore to deliver products such as transmission oil coolers, power steering coolers, fuel coolers, transfer case coolers and complete cooling packages. Rocore has also earned the trust of mobile equipment customers that rely on our cooling products for the most challenging off-road construction and industrial equipment applications.

## POWER GENERATION AND INDUSTRIAL

In the stand-by and prime power markets, no one delivers a more impressive line of power generation cooling packages. Our extensive capabilities allow us to engineer, design and manufacture systems in sizes ranging from a few square feet to more than one hundred square feet, and incorporating multiple cores and complex structures. Our broad product base also enables us to source all required cooling products from within our business. In addition, premier customers in the compressor industry have relied on Rocore for our design and application expertise.





## **AFTERMARKET**

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For the most demanding industrial applications, Rocore delivers heavy-duty aftermarket products that stand up to the toughest operating conditions. With Rocore's experienced engineering resources and manufacturing capabilities we can provide standard or custom designed products including copper/brass cores, complete radiators, shell and tube water to oil coolers, and more. Best of all, our aftermarket products are all backed by our engineering and application expertise.

## **MILITARY**

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Rocore is extremely proud of our 20+ years of experience supporting our military infrastructure and systems heat exchanger needs. Just like the military personnel they serve, Rocore cooling systems perform under the most stringent operating environments.

## **RAIL**

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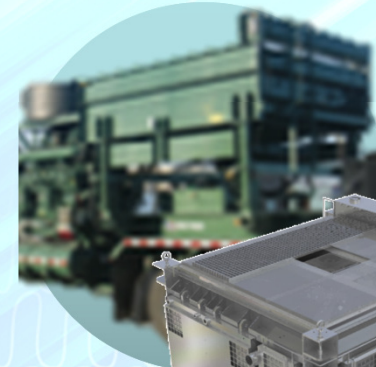
Rocore designs, engineers and manufactures a comprehensive range of mechanically bonded radiators, oil coolers, after coolers, intercoolers and complete cooling packages for new and aftermarket rail applications.

## OIL & GAS (UPSTREAM)

Rocore has an extensive experience and product portfolio for application on land drilling systems (traditional and non-traditional fracking), as well as off-shore. Our Cube™ module addresses many of the challenges for long-term Fracking applications, including packaging and fin clean-off. We also offer a Shell & Tube product portfolio for these demanding duty cycle applications.

## PETRO/CHEMICAL AND MARINE

Rocore and its CTI Industries Business Group has the product and tube restoration service capabilities to extend heat exchanger performance life in this very corrosive and demanding safety environments. In 1976, CTI developed a tube repair technique that today is recognized as the most widely used and cost-effective system for heat exchanger repair. These techniques and services apply to the electric utility, marine, petroleum, chemical, paper mill, and fertilizer industries and are in place in over 45 countries throughout the world.



*Confidential*

*Cooling Systems for Prime Power and Back-up Power Generation*

*WHAT'S TRENDING in POWER-GEN*



## Tier 4

- Typically adds more heat to the cooling circuit.
- May require engine re-certification for installation of a non-factory cooling system.
- Nothing Magic about Tier 4: just need to conform to engine datasheet.
- Emergency Standby Generators, ESP, are exempt and can be Tier 2 or Tier 3 depending on the power rating. (California likely requires ESP to be Tier 4.)



Tier 4 should be fully implemented

## PHASE-IN SCHEDULE

ekW	2009	2010	2011	2012	2013	2014	2015
> 2000	T2	T2	T4 Interim	T4 Interim	T4 Interim	T4 Interim	T4 Final
500 – 2000	T2	T2	T4 Interim	T4 Interim	T4 Interim	T4 Interim	T4 Final
230 – 450	T3	T3	T4 Interim	T4 Interim	T4 Interim	T4 Final	T4 Final
125 – 200	T3	T3	T4 Interim	T4 Interim	T4 Interim	T4 Final	T4 Final
70 – 100	T3	T3	T3	T4 Interim	T4 Interim	T4 Interim	T4 Final
45 – 60	T3	T3	T3	T4 Interim	T4 Interim	T4 Interim	T4 Final
15 – 30	T4 Interim	T4 Interim	T4 Interim	T4 Interim	T4 Final	T4 Final	T4 Final
< 15	T4	T4	T4	T4	T4	T4	T4



GenSet Conversion: remove factory radiator and replace with alternate cooling package.

BEFORE



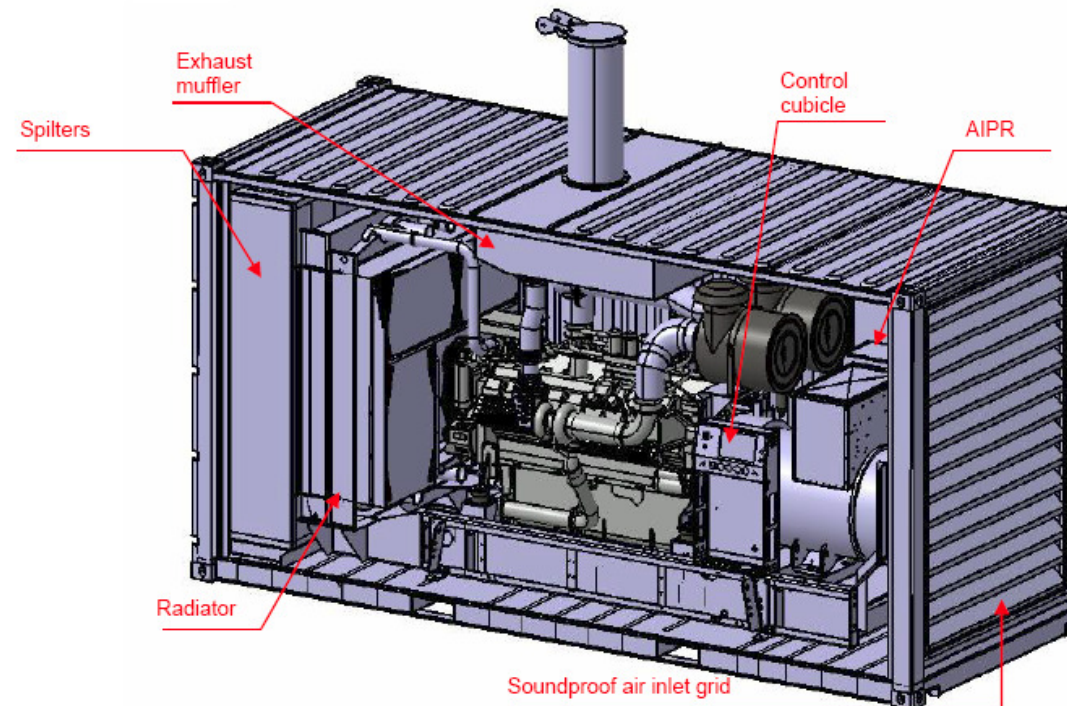
AFTER


 Remote Charge Air Coolers: required for remote radiator applications with engines designed for air-to-air charge air cooling.



## Low/Reduced Sound and Vibration Levels

- Silencing treatments add resistance to the air flow.
- Fan noise typically reduced by lower speed (and losing performance and increasing size)



 Low/Reduced Sound and Vibration Levels

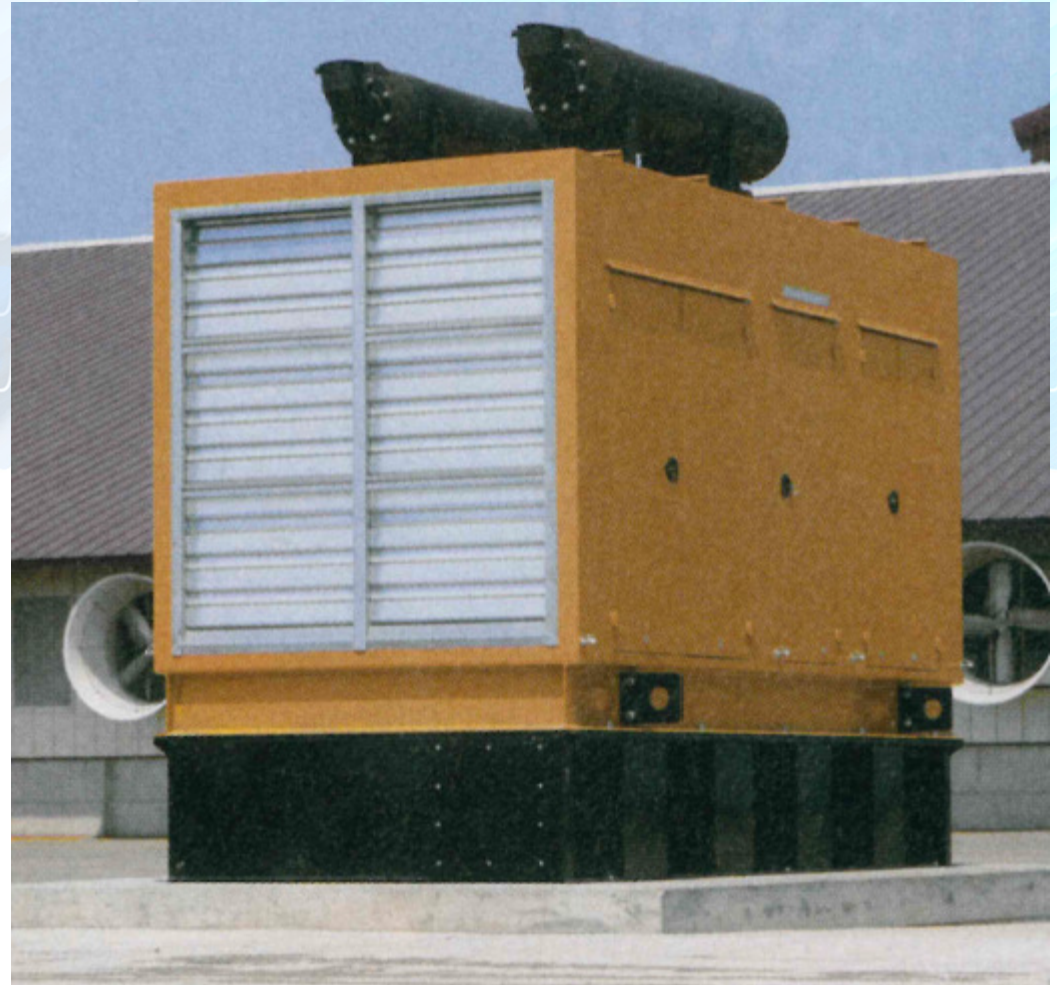
- Louvered-panel sound attenuating panels around legs of horizontal remote radiators.





## Low/Reduced Sound and Vibration Levels

- Mounting GenSet on a base fuel tank (or isolation springs) helps reduce transmission of vibration.






## Low/Reduced Sound and Vibration Levels

- Replacement of diesel-engine driven pumps with electric-motor drives in oil-field applications.
- PowerGen provided by on-site gas-turbine generators.



*Clean Fleet<sup>®</sup> pump truck with totally independent, twin 1750 HHP engines (3500 total HHP per trailer)*




 Maintenance and Testing

Maintenance Quality	Number of Failures		Failures Due to Inadequate Maintenance (%)
	All Causes	Inadequate Maintenance	
Excellent	331	36	11.6
Fair	853	154	18.1
Poor	67	22	32.8
<b>Total</b>	<b>1469</b>	<b>240</b>	<b>16.3</b>

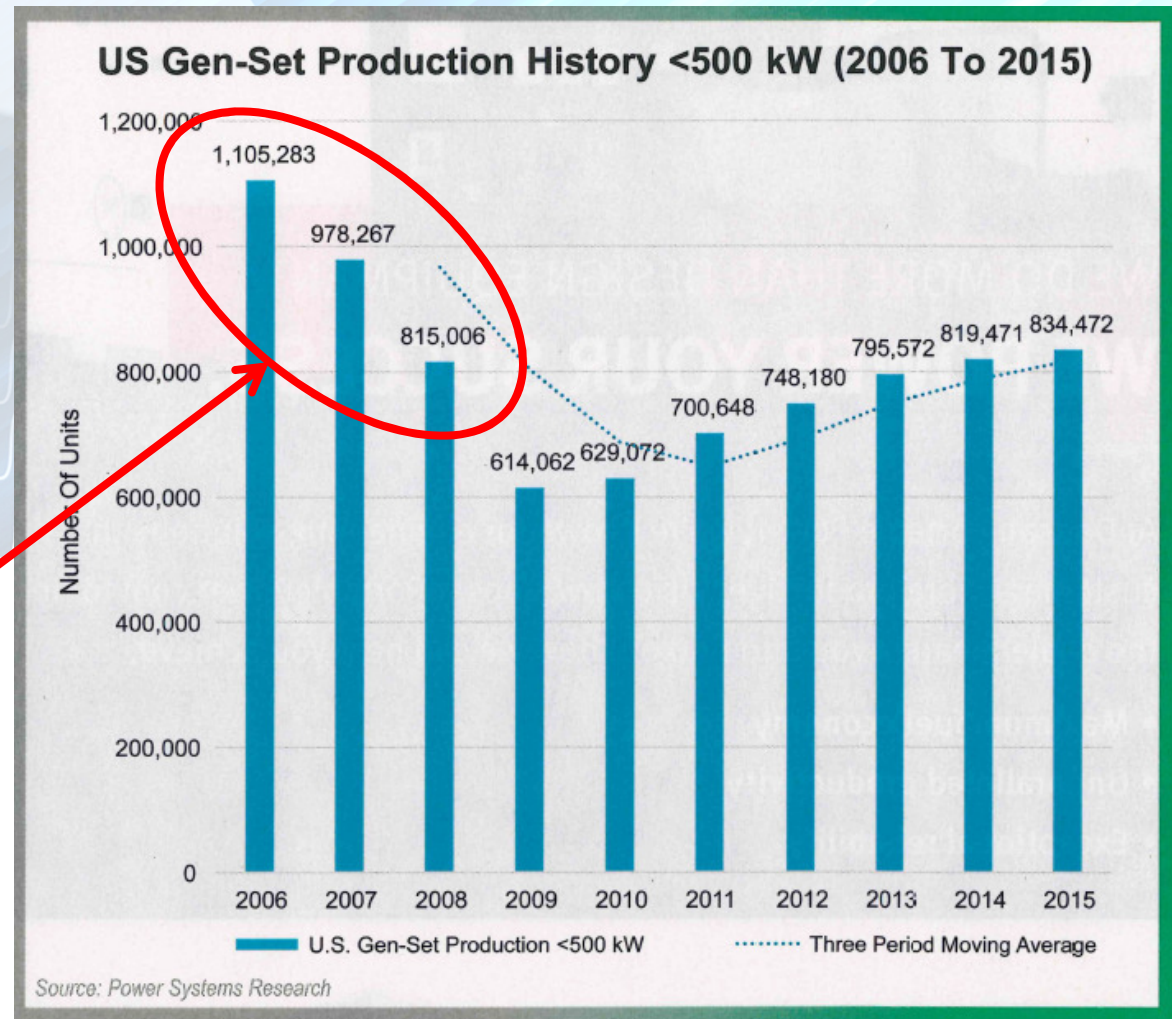
TABLE 2: Summary of Survey Conducted by the IEEE Industrial and Commercial Power Systems Committee


It is reckoned that only 2.5% of radiators currently fail during their first five years. In the late 1980s this figure was almost 9%.

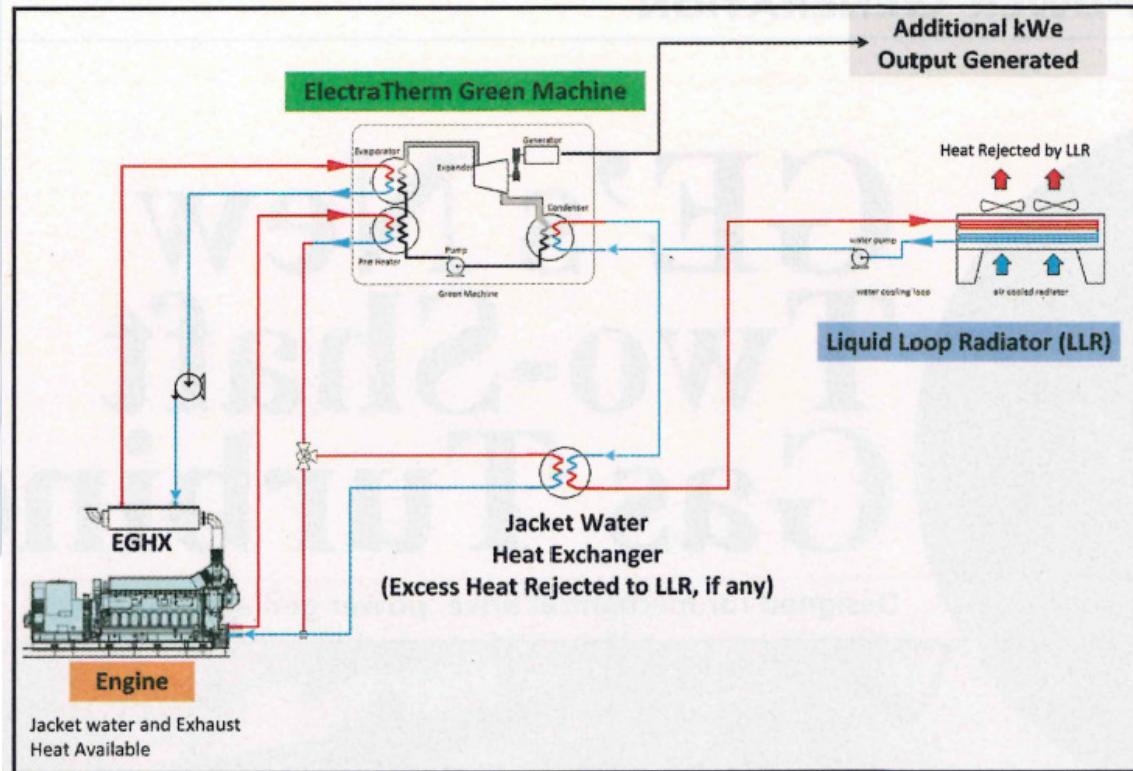
"Just-Auto.com"

 More service due to aging???

8, 9 and 10 years old



 Co-Gen and other Waste Heat Recovery




The engine radiator is replaced by the Green Machine ORC and its condenser, a liquid-loop radiator, which captures both the engine jacket water and exhaust for maximum electrical output. A secondary loop is configured between the engine and the condenser for the ORC, and this loop controls the return temperature of the jacket water to the engine.

## New Fan Design/Technology

- Horton using thermoset fans as substitute for heavy steel fans with laminated spider/hubs (HTEC).
- Multi-Wing created new blade profiles to generate higher static pressure.

 More Aluminum?!

According to the International Copper Association, aluminium has largely replaced copper in the original-equipment automotive radiator market, particularly in the US.

 Will the trend continue to PowerGen?

- Rocore Hydraulic Fracturing CUBE cooler; all coolers are Aluminum Bar & Plate.
- 2500 HP Rating.



# QUESTIONS ???

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